A Lactic Acid Bacterial Strain to Improve Aerobic Stability of Silages

R.E. Muck

Introduction

Inoculants containing lactic acid bacteria are common additives used by farmers in the U.S. and other parts of the world in making silage. These products help guarantee a rapid and efficient fermentation of a crop in the silo. When inoculant bacteria dominate fermentation, lactic acid relative to other fermentation products increases, dry matter recovery is improved, and animal performance may be enhanced. However, these products have been found in many cases to make silages more susceptible to heating and spoilage by yeasts and molds once the silage is exposed to air. This has been particularly true in corn and small grain silages. The goal of this study was to determine if several strains of microorganisms found in aerobically stable silages might improve a silage's resistance to heating.

Methods

Similar trials were performed in two succeeding years. Whole plant corn was chopped with a forage harvester and ensiled in 15 cm ID by 60 cm long PVC pipe silos. One end of the pipe was sealed with a rubber cap — the other with black polyethylene sheeting secured by duct tape. There were two replicate silos for each of five treatments: control and four inoculant strains applied at approximately 10^5 microorganisms/g crop. Two strains were lactic acid bacteria, and two were yeasts, all of which were isolated from aerobically stable silages. The microorganisms were grown individually in batch culture and diluted so that application rates were 1 ml inoculant solution/50 g crop. The control was sprayed with distilled water at the same rate.

After a minimum of 90 days of storage, the silos were opened. Depth of the moldy layer underneath the plastic was measured and discarded. The remaining silage was removed by 15 cm units of depth so that there were four blocks of silage per silo. Each block was analyzed for pH, dry matter, fermentation products, and aerobic stability. Aerobic stability was assessed by the time required for the silage to heat 1 °C above ambient temperature when stored aerobically in styrofoam buckets.

Results and Discussion

In general, the top layer or layer closest to the black polyethylene sheeting was the least stable, and the lower three layers were of similar aerobic stability. Of the various treatments, only one provided substantial and consistent improvements in aerobic stability over the control. As shown in Table 1, this microorganism, *Lactobacillus buchneri* TY16, more than doubled the time until heating with the exception of the top layer in the first year. The TY16 silages in the second year did not heat over the course of the aerobic stability test (37 d of aerobic exposure). In both years, acetic acid was higher in the TY16 silages, and in the second year, significant levels of propionic acid were measured in the TY16 silages. This lactic acid bacteria is a heterofermentative microorganism and would be expected to boost acetic acid content, improving aerobic stability. Propionic acid is a stronger inhibitor of yeasts and molds than acetic acid. The mechanism of propionic acid production is not known at this time, and it is unclear if this is directly from the activity of TY16.

Conclusions

These results suggest that *Lactobacillus buchneri* TY16 is a very promising microorganism for improving the aerobic stability of silage. Current studies are in progress investigating various aspects important to the commercialization of this microorganism. These studies are investigating the appropriate rate of application relative to other strains in a potential product, stability of the microorganism, and effects of the

microorganism on animal performance. Such studies are being carried out in collaboration with Cargill, Inc. under a cooperative research and development agreement.

Table 1. Comparison of the characteristics of corn silages made with and without inoculation with *Lactobacillus buchneri* TY16.

	Year 1		Year 2	
	Control	TY16	Control	TY16
Moldy layer, cm	5.3	5.5	7.0	0.0
Time to heat, h				
Top layer	35	57	144	> 900
Lower layers	84	231	212	> 900
pH	3.84	3.86	3.85	4.36
Dry matter, %	33.1	32.8	31.3	29.7
Fermentation products				
Lactic acid*	5.68	5.57	6.50	1.35
Acetic scid*	1.59	2.81	1.64	5.87
Propionic acid*	0.00	0.00	0.01	0.46
Butyric scid*	0.00	0.00	0.00	0.00
Ethanol*	1.12	1.06	0.32	0.76
Aerobic microorganisms				
Yeasts+	2.4	3.6	< 2.0	< 2.0
Molds+	< 2.0	< 2.0	2.5	< 2.0
Acetic acid bacteria+	6.6	7.4	< 2.0	< 2.0

*% Dry matter; average of the lower three layers.

+Log_{10}(microorganisms/g silage); average of the lower three layers.